Hall Ticket No | | | | | | | | | | | Question Paper Code: AMEB17

INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)

Dundigal, Hyderabad - 500 043

MODEL QUESTION PAPER-II

B.Tech V Semester End Examinations, November 2020

Regulations: IARE - R18

DYNAMICS OF MACHINERY

MECHANICAL ENGINEERING

Time: 3 hour | Maximum Marks: 70

Answer ONE Question from each MODULE
All Questions Carry Equal Marks
All parts of the question must be answered in one place only

MODULE-I

1. (a) Explain the gyroscopic effect of a four wheeler negotiating a curve. [**7m**]

   (b) The mass of turbine rotor of a ship is 8 tonnes and has a radius of gyration of 0.6 meters. It rotates at 1800 rpm clockwise when looking from the front. Determine the gyroscopic effect if

   (i) The ship is travelling at 100 km/h and steers to the right in a curve of 70 meters radius.

   (ii) The ship is pitching and the bow descends with maximum velocity. The complete oscillation takes 20 $seconds$.The pitching is simple harmonic and the total angular movement between the extreme positions is 10 degrees.

   (iii) The ship is rolling and at a certain instant has an angular velocity of 0.03 $radians/second$ clockwise when looking from bow.

   [**7m**]

2. (a) Explain the effect of gyroscopic couple on an aeroplane when taking left turn. [**7m**]

   (b) The mass of the motor cycle along with the rider is 180 kg. The height of the centre of gravity of total mass is 600 mm above the ground when it moves straight. Each wheel has a diameter of 700 mm and mass moment of inertia of $2kgm$ The engine rotates at a speed of 5 times the road wheel and engine rotating parts have mass moment of inertia of $0.2kgm$. Estimate the angle of heel if it is travelling at $50km/h$ and is taking a turn of $30meters$ radius.

   [**7m**]

MODULE-II

3. (a) Deduce expression for the friction torque for a single plate clutch considering uniform wear. [**7m**]

(b) Determine the axial force required to engage a cone clutch transmitting 20 kW of power at 750 rpm. Average friction diameter of the cone is 400 mm and average pressure intensity 60 kN/m^2. Semi cone angle is 10^0 and coefficient of friction is 0.25.Also Estimate the width of the friction cone. [**7m**]

4. (a) Deduce expression for the friction torque for multiplate clutch considering uniform pressure. [**7m**]

   (b) A conical pivot supports a load of 20 kN, cone angle is 12^0 and intensity of pressure normal to the cone is $0.3N/m^2$. The outer diameter is twice the inner diameter. Estimate the outer and inner radii of bearing surface if the shaft rotates at 200 rpm and $\mu = 0.1$. Estimate the power absorbed in friction assuming uniform wear. [**7m**]

MODULE-III

5. (a) Describe the Coefficient of fluctuation of speed of a multi cylinder engine. [**7m**]

   (b) The effective turning moment exerted by a two stroke engine at crank shaft is $T = 8000 + 1000\sin 2\theta - 2000\cos 2\theta$ where θ is the inclination of the crank to inner dead center. The mass of the flywheel is 500 kg and radius of gyration is 750 mm . The engine speed is 300 rpm. Determine the power developed, the total percentage fluctuation of speed and maximum angular retardation. [**7m**]

6. (a) Describe the porter governor. [**7m**]

   (b) The turning moment diagram for a multi cylinder engine has been drawn to a scale of 1 mm to 500 Nm of torque and 1 mm to 60 of crank displacement The intercepted areas between the output torque curve and the mean resistance line taken in order from one end of the engine are $-30, +410, -280, +320, -330, +250, -360, +280, -260mm^2$ when the engine runs at 800 rpm. The engine has a stroke of 300 mm and the fluctuation of speed is not to exceed 2% of mean speed. Determine suitable diameter and cross section of the flywheel rim for a limiting value of safe centrifugal stress of $7MP$. The material density is 720 kg/m^3. Width of the rim is 5 times the thickness. [**7m**]

MODULE-IV

7. (a) Explain the balancing of rotating masses with a neat sketch. [**7m**]

   (b) The cranks of a three cylinder locomotive are set at 1200. The stroke is 120 mm, the length of the connecting rod is 240 mm, the mass of the reciprocating parts per cylinder is 1 Kg and the speed of the crank shaft is $2400rpm$. Determine the magnitude of primary and secondary balancing. [**7m**]

8. (a) Explain the method of balancing different masses revolving in the same plane. [**7m**]

   (b) A single cylinder horizontal engine runs at 120 rpm. The length of stroke is 400 mm. The mass of the revolving parts assumed concentrated at the crank pin, is 100 Kg and mass of reciprocating parts is 150 Kg. Determine the magnitude of the balancing mass required to be placed opposite to the crank at a radius of 150mm which is equivalent to all the revolving masses and 2/3 of the reciprocating masses. If the crank turns 300 from the inner dead center, Estimate the magnitude of the unbalanced force due to the balancing mass. [**7m**]

MODULE-V

9. (a) Explain the free and forced vibrations. [**7m**]

   (b) Estimate the whirling speed of a shaft 20 mm diameter and 0.6 m long, carrying a mass of 1 kg at its mid point. Density of the shaft material is 40 kg/m^3 and $E = 200GN/m^2$. Assume freely supported shaft. [**7m**]

10. (a) Explain the various types of damping? [**7m**]

    (b) A single cylinder engine of total mass 200 kg is to be mounted on an elastic support which permits vibratory movement in vertical direction only. The mass of the piston is 3.5 kg and has a vertical simple harmonic motion with a stroke of 150 mm. It is desired that the maximum vibratory force transmitted through the elastic support to the foundation shall be 600 N when the engine speed is 800 rpm. Estimate the necessary stiffness of the elastic support and the amplitude of vibration at 800 rpm. [**7m**]

****END OF EXAMINATION****

COURSE OBJECTIVES:

The course should enable the students to:

1	The concepts of precision, static and dynamic forces of planer mechanisms by neglecting friction of aero planes, sea vessels, auto mobiles and various force members.
2	The knowledge of engineering mechanics for identifying the coefficient of friction and engine speed of the various contact bodies (Clutches and Brakes) and speed controlled devices, variations of torques and fluctuation of speeds of IC engines.
3	The magnitude and direction of balanced mass for unbalanced rotary and reciprocating engines with the fundamentals of applied physics.
4	Mathematical modeling of various degree of freedom systems to interpret the various vibration parameters.
5	The affluence of real world engineering problems and examples towards gaining the experience for how dynamics of machinery is applied in engineering practice.

COURSE OUTCOMES:

After successful completion of the course, students should be able to:

CO 1	Discuss the Gyroscopes, effect of precession motion on the stability of moving vehicles such as motor car, motor cycle, aeroplanes and ships.
CO 2	Determine the angle of heel to avoid upside down of a two wheeler vehicle while taking in left and right turns.
CO 3	Illustrate the static and dynamic force analysis of two and three force members by graphical super position method.
CO 4	Apply the laws of friction on clutches, brakes and dynamometers to reduce the power losses for the effective torque transmission.
CO 5	Justify the importance of torque and fluctuation of speeds for single and multi cylindered engines to increase the mechanical efficiency.
CO 6	Estimate the height of a governor to regulate the speed of a prime mover at various load conditions.
CO 7	Determine the balanced mass for unbalanced rotary and reciprocating engines by analytical and graphical methods.
CO 8	Develop a mathematical modelling of free and forced vibration systems under damped and un-damped conditions to avoid the vibratory damages of aero-mechanical-civil structures and electrical and electronic components at various operated frequencies.
CO 9	Use the resonance phenomenon to predict the critical or whirling or whipping speeds of various structures under vibrations to avoid catastrophic failures.
CO 10	Apply the principles of dynamics of machinery to a real world problems for obtaining optimum solutions.

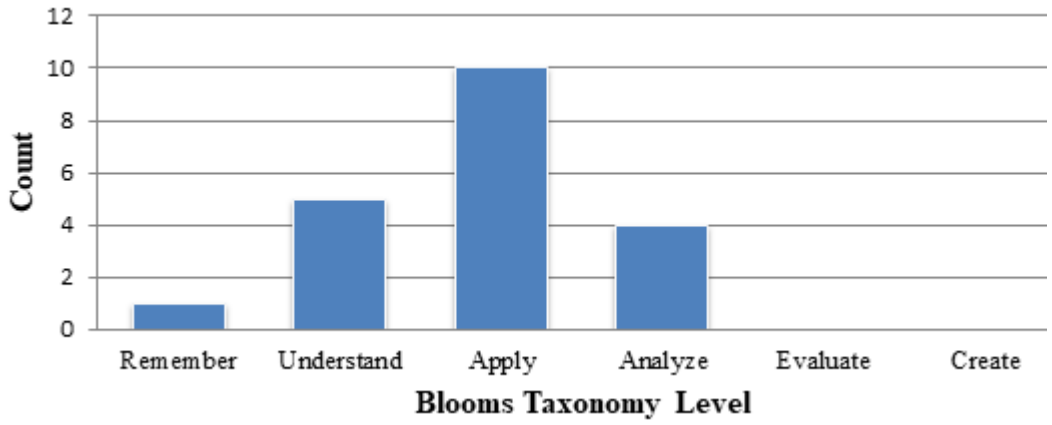
MAPPING OF SEMESTER END EXAMINATION QUESTIONS TO COURSE OUTCOMES

Q.No		All Questions carry equal marks	Taxonomy	CO's	PO's
1	a	Explain the gyroscopic effect of a four wheeler negotiating a curve.	Understand	CO 1	PO 1
	b	The mass of turbine rotor of a ship is 8 tonnes and has a radius of gyration of 0.6 meters. It rotates at 1800 rpm clockwise when looking from the front. Determine the gyroscopic effect if (i) The ship is travelling at 100 km/h and steers to the right in a curve of 70 meters radius. (ii) The ship is pitching and the bow descends with maximum velocity. The complete oscillation takes 20 $seconds$.The pitching is simple harmonic and the total angular movement between the extreme positions is 10 degrees. (iii) The ship is rolling and at a certain instant has an angular velocity of 0.03 $radians/second$ clockwise when looking from bow.	Apply	CO 2	PO 2
2	a	Explain the effect of gyroscopic couple on an aeroplane when taking left turn.	Understand	CO 2	PO 1,2
	b	The mass of the motor cycle along with the rider is 180 kg. The height of the centre of gravity of total mass is 600 mm above the ground when it moves straight. Each wheel has a diameter of 700 mm and mass moment of inertia of $2kgm$ The engine rotates at a speed of 5 times the road wheel and engine rotating parts have mass moment of inertia of $0.2kgm$. Estimate the angle of heel if it is travelling at $50km/h$ and is taking a turn of $30meters$ radius.	Apply	CO 1	PO 1
3	a	Deduce expression for the friction torque for a single plate clutch considering uniform wear.	Understand	CO 4	PO 1
	b	Determine the axial force required to engage a cone clutch transmitting 20kW of power at 750 rpm. Average friction diameter of the cone is 400 mm and average pressure intensity $60kN/m^2$. Semi cone angle is 10^0 and coefficient of friction is 0.25.Also Estimate the width of the friction cone.	Apply	CO 4	PO 1
4	a	Deduce expression for the friction torque for multiplate clutch considering uniform pressure	Understand	CO 4	PO 1

	b	Deduce expression for the friction torque for multiplate clutch considering uniform pressure.A conical pivot supports a load of 20 kN, cone angle is 12^0 and intensity of pressure normal to the cone is $0.3N/m^2$. The outer diameter is twice the inner diameter. Estimate the outer and inner radii of bearing surface if the shaft rotates at 200 rpm and $\mu = 0.1$. Estimate the power absorbed in friction assuming uniform wear.	Apply	CO 4	PO 2,4
5	a	Describe the Coefficient of fluctuation of speed of a multi cylinder engine.	Understand	CO 4	PO 1
	b	The effective turning moment exerted by a two stroke engine at crank shaft is $T = 8000 + 1000 \sin 2\theta - 2000 \cos 2\theta$ where θ is the inclination of the crank to inner dead center. The mass of the flywheel is 500 kg and radius of gyration is 750 mm . The engine speed is 300 rpm. Determine the power developed, the total percentage fluctuation of speed and maximum angular retardation.	Apply	CO 5	PO 1
6	a	Describe the porter governor.	Understand	CO 4	PO 12
	b	The turning moment diagram for a multi cylinder engine has been drawn to a scale of 1 mm to 500 Nm of torque and 1 mm to 60 of crank displacement The intercepted areas between the output torque curve and the mean resistance line taken in order from one end of the engine are $-30, +410, -280, +320, -330, +250, -360, +280, -260 mm^2$ when the engine runs at 800 rpm. The engine has a stroke of 300 mm and the fluctuation of speed is not to exceed 2% of mean speed. Determine suitable diameter and cross section of the flywheel rim for a limiting value of safe centrifugal stress of $7MP$. The material density is 720 kg/m^3. Width of the rim is 5 times the thickness.	Apply	CO 5	PO 2,4
7	a	Explain the balancing of rotating masses with a neat sketch.	Understand	CO 7	PO 1

	b	The cranks of a three cylinder locomotive are set at 1200. The stroke is 120 mm, the length of the connecting rod is 240 mm, the mass of the reciprocating parts per cylinder is 1 Kg and the speed of the crank shaft is 2400 rpm. Determine the magnitude of primary and secondary balancing.	Apply	CO 7	PO 2,4
8	a	Explain the method of balancing different masses revolving in the same plane.	Understand	CO 7	PO 1
	b	A single cylinder horizontal engine runs at 120 rpm. The length of stroke is 400 mm. The mass of the revolving parts assumed concentrated at the crank pin, is 100 Kg and mass of reciprocating parts is 150 Kg. Determine the magnitude of the balancing mass required to be placed opposite to the crank at a radius of 150mm which is equivalent to all the revolving masses and 2/3 of the reciprocating masses. If the crank turns 300 from the inner dead center, Estimate the magnitude of the unbalanced force due to the balancing mass.	Apply	CO 7	PO 2,4
9	a	Explain the free and forced vibrations.	Understand	CO 8	PO 1
	b	Estimate the whirling speed of a shaft 20 mm diameter and 0.6 m long, carrying a mass of 1 kg at its mid point. Density of the shaft material is 40 kg/m^3 and $E = 200GN/m^2$. Assume freely supported shaft.	Apply	CO 8	PO 1
10	a	Explain the various types of damping?	Understand	CO 9	PO 1
	b	A single cylinder engine of total mass 200 kg is to be mounted on an elastic support which permits vibratory movement in vertical direction only. The mass of the piston is 3.5 kg and has a vertical simple harmonic motion with a stroke of 150 mm. It is desired that the maximum vibratory force transmitted through the elastic support to the foundation shall be 600 N when the engine speed is 800 rpm. Estimate the necessary stiffness of the elastic support and the amplitude of vibration at 800 rpm.	Apply	CO 8	PO 2

KNOWLEDGE COMPETENCY LEVELS OF MODEL QUESTION PAPER



Signature of Course Coordinator **HOD, ME**
Mr. A Somaiah, Assistant Professor